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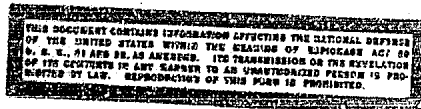
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USSR AGRICULTURE EXPERIMENTS WITH ELECTRIC TRACTORS

The USSR is striving for extensive electrification of its agriculture. To this end, about 11,000 agricultural electric power plants with a total capacity of 275,000 kilowatts had been established up to World War II; at that time, power consumption in agriculture was 425 million kilowatt-hours annually. At the beginning of 1941, electric power was being used by 10,000 kolchozes, 2,500 MTS, and many hundreds of sovkhoses.

In 1945, construction was begun on power plants with a capacity five times as great as that of all plants put in operation in 1940. In 1945, 3.5 times as many kolchozes and ten times as many MTS were electrified as in 1940.

By the end of the postwar Five-Year Plan in 1950, the capacity of agricultural electric power plants had risen to a level which was 2.8 times the 1940 level.

Increasing capacity of plants added since 1945 may be illustrated in the following manner: if new capacity added in 1945 is considered as 100, then new capacity added was 177 in 1946, 228 in 1947, 292 in 1948, 309 in 1949, and 323 in 1950.

Thus far, electric power in agriculture has been used primarily for operations of a stationary nature. For operations which require mobile power, such as plowing, sowing, cultivating, and harvesting, tractors with internal combustion engines have been used.

About 40 percent of all labor in kolchozes of the USSR is expended in performing the mobile operations of plowing, sowing, harrowing, cultivating, and harvesting. Of all power resources (including tractors, combines, trucks, stationary engines, electric motors, and draft animals) in USSR agriculture, about 50 percent is used for the mobile operations, about 32 percent for transport operations, and about 18 percent for stationary operations.

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Initial efforts to design electrically operated plowing equipment resulted in the so-called electric plow drawn by a cable (electric winch system). A number of these plows were in operation between 1921 and 1937 on fields serviced by Kantserovskaya MTS in Zaporozh'ye Oblast and Engle'skaya MTS in Saratov Oblast.

Extensive experience proved that electric plows of this type were impractical for general use. They contained four times as much metal as the CHIZ tractor, a machine of comparable power. They could be used only for plowing; attempts to create attachable equipment for harrowing, cultivating, etc., were unsatisfactory. They could be used only for distances not exceeding 500 meters from the winch; even for this distance, pulling of the cable required 10-15 percent of the winch capacity. Weight of the plow was 5-6 tons. Its operation required considerable physical exertion on the part of the plowman, and his workday could not, as a rule, exceed 4 hours.

Simultaneously with the design of the described electric plow, self-propelled electric machines for field work and electric tractors fed by means of flexible cables were being devised. One of the first such machines was an electric plow designed by Soviet Engineer Prekht and demonstrated at the 1923 Agricultural Exposition in Moscow. Several types of electric tractors were developed by Soviet engineers (including Professor Didebulidze and Engineer Krasnov), but all proved inefficient. The main difficulty which baffled the designers was the matter of feeding electric current from its immobile source to the machine moving on the field. Finally, in 1937, Professor P. N. Listov and Engineer V. G. Stetsenko of VIESKh (All-Union Scientific Research Institute for Electrification of Agriculture) succeeded in creating a design for an efficient electric tractor. From 1937 to 1948, VIESKh developed and tested eight different models of tractors with flexible cable feed. The tests, carried out by Engel'skaya MTS in Saratov Oblast, demonstrated the technical advantages and economic efficiency of this tractor over the earlier winch-system type of machine.

In the spring of 1949, 30 BT-5 electric tractors were sent to Rybnovskaya MTS in Ryazan' Oblast, Korsun'-Shevchenkovskaya MTS in Kiev Oblast, and Bazhanovskaya MTS in Sverdlovsk Oblast for experimental use. Subsequently, electric tractors were also used by Yangi-Yul'skaya MTS in the Uzbek SSR, Kardonikskaya MTS in Stavropol' Kray, and other MTS.

An important condition for extensive use of electric tractors is power availability. As previously indicated, electrification of mobile agricultural operations would require considerably more power than is necessary for electrification of stationary operations. For example, according to calculations made for the Stalingrad Hydroelectric Plant zone it will require 530 kilowatts to electrify stationary operations on 20,000 hectares of plow land but about 2,000 kilowatts to electrify mobile operations.

Considering the size of present MTS, 20,000 hectares of plow land is admittedly the minimum area serviced by one MTS. Thus, to electrify mobile and stationary operations in kolkhozes served by one MTS would require an electric power plant with about 2,000-kilowatt capacity. In the postwar period, the number of plants with higher capacity has risen sharply. The capacities of Kaz'minskaya Interkolkhoz Hydroelectric Power Plant in Ryazan' Oblast, Tzipon'skaya Agricultural Hydroelectric Power Plant in the Georgian SSR, and Korsun'-Shevchenkovskaya Hydroelectric Power Plant in Kiev Oblast exceed 1,000 kilowatts. Analysis of existing plans for utilization of local power resources in agricultural electrification shows that it would be possible to build considerable numbers of agricultural hydroelectric plants with more than 1,000-kilowatt capacity during the next few years.

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Prospects for electrifying mobile field operations are especially favorable in the zones along the Volga, Don, and Dnepr, where the gigantic hydroelectric plants are being built. Electrification of plowing, sowing, harrowing, cultivating, and threshing will be possible there, both because large quantities of cheap power will be available, and because it can be combined with electrification of irrigation. Such dual electrification will permit fuller and more rational utilization of electrical installations (lines and substations) and increase economic efficiency of electrification. As shown by 3 years of experience with the first group of electric tractors operating under actual production conditions, the economic efficiency of electrification is considerable.

The most substantial indexes of economic efficiency of rural electrification are the effects of electrification on labor utilization and labor productivity. The higher labor productivity resulting from electrification permits production operations and processes to be performed in shorter periods of time and also makes them easier.

Since a characteristic peculiarity of agriculture is its seasonality, and the consequent uneven expenditure of labor in various seasons, the leveling of seasonal variations in labor expenditure is another important index of the efficiency of electrification. Electrification also promotes further mechanization, automatization, and rationalization in agriculture.

Electrification will require more knowledge and higher qualifications on the part of agricultural workers and will level the existing disparity between physical and mental labor.

Electrification will result in more rational utilization of the means of production. It will permit use of local power resources in place of imported liquid fuel for production operations and will reduce fuel consumption for transport purposes.

Electrification will have influence on raising the yield and improving the quality of agricultural products.

Electrification will strengthen state control over kolkhoz production through the broadened functions of MTS and through state power organizations.

The economic efficiency of electric tractors can be specifically determined from the experience gained from their use. As stated above, electric tractors were operated for the last 3 years in a number of MTS, located in various zones of the USSR. For purposes of determining operational indexes, mainly data compiled in Rybnovskaya, Bazhenovskaya, and Korsun'-Shevchenkovskaya MTS, where electric tractors were operated all 3 years and where they accounted for about 23 percent of all electric tractor power in the USSR will be cited. During the 3 years, the tractors in these MTS worked more than 60,000 hectares in terms of soft plowing; the work included spring plowing, summer fallow plowing, stubble plowing, harrowing, disk harrowing, virgin soil plowing, winter fallow plowing, grain crop sowing, grain harvesting, potato planting, and harvesting, etc.

To provide a correct estimate of the economic efficiency of electric tractors, their operational indexes were compared with those of STZ-MATI internal-combustion caterpillar tractors performing the same operations in the same MTS. While STZ-MATI and ET-5 electric tractors are similar in type and power, there are some technical differences; for this reason, correction factors were applied to the actual data concerning electric tractor performance so as to make the two sets of data comparable.

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A basic advantage of electric tractors is that they eliminate the need for liquid fuel. On the average, 18 kilograms of oil products are saved per hectare of soft plowing. Electric power consumption per hectare of soft plowing averages 45 kilowatt-hours. In other words, every kilowatt-hour of electric power used for electrification of field operations conserves 0.4 kilogram of oil products.

If field operations on several million hectares in the irrigated zones of the great hydroelectric projects are electrified, as planned, resultant savings of oil products will total hundreds of thousands of tons annually.

Another advantage of the electric tractor is that it eases the task of the worker and improves his working conditions. Operations of the electric tractor require less physical strength than operations of the internal combustion tractor. It requires no servicing with fuel and water, emits no exhaust gases, and gives good light for night work. Its even rate of speed and heavy weight assure a uniform plowing depth, regardless of soil condition. Available data, based on results obtained from similar experimental plots, one worked by internal combustion tractor and the other by electric tractor, lead to the conclusion that use of electric tractors increases the yield of agricultural crops.

Productivity of the ET-5 electric tractor in 1951 in all three MTS was 7.8 hectares of soft plowing per shift and that of the STZ-MATI, 7.7 hectares per shift (a correction factor was applied for the difference in speed of the two tractors). It is important to note that productivity per shift of the ET-5 is steadily increasing: by 1951, it had become 20 percent higher than in 1949.

Indexes concerning man-hours spent in operating the two types of tractors also favor the electric tractor. The following table showing distribution of work time illustrates this fact for summer fallow plowing in Rybnovskaya MTS in 1949.

	<u>ET-5</u>	<u>STZ-MATI</u>
	(percent of total)	
Operating time	69.8	71.4
Basic work	53.9	47.8
Idle time	30.2	28.6
For technical reasons	11.7	18.3
For organizational reasons	12.0	7.4
For labor reasons	2.8	2.4
Total	100.0	100.0

The table shows that the portion of time applied to basic work was greater for the electric tractor even in 1949, the first year of its exploitation. In 1950, in the same MTS, the portion of time applied to all work (again summer fallow plowing) had risen to 73.2 percent and that applied to basic work, to 63.4 percent. When all types of operations in various MTS were considered, the portion of time devoted to basic work ranged between 45.1 and 50.8 percent for electric tractors and 48.0 and 48.6 percent for STZ-MATI tractors.

Higher labor productivity is another result of electrifying agricultural production processes. In grain winnowing and grading, it rises two to three times; fodder preparation, five to ten; milking, two to three; and sheep shearing, three times. The increase is explained mainly by the fact that prior to electrification, these processes were performed manually or with simple machines driven by man- or horsepower.

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Such great labor productivity increases cannot be expected from using the electric tractor in place of the internal combustion tractor, which is itself a modern machine. The electric tractor still pulls the same equipment (plows, drills, etc.) as the internal combustion tractor. The following table illustrates the rise in labor productivity attained before World War II through use of the latter tractor and attached machines:

Number of Man-Days per Hectare of Spiked Grain Crops

Individual peasants, 1922 - 1925	20.8
Kolkhozes, 1933	12.3
Kolkhozes, 1937	10.5

If only those operations for which electric tractors are now used are taken into consideration, the results are as shown in the table below:

Number of Man-Days per Hectare of Spiked Grain Crops
(including only soil preparation and care of crops)

Individual peasants	6.51
Kolkhozes, 1933	4.55
Kolkhozes, 1937	3.53

Thus, even before the war, use of internal combustion tractors cut labor expenditure per hectare of spiked grain crops almost in half.

The following table compares actual labor productivity of various types of workers in connection with use of the two tractors:

Number of Man-Days per 100 Hectares of Soft Plowing

<u>Workers</u>	<u>ET-5</u>	<u>STZ-MATI</u>
Tractor and attached machine operators, brigadiers, and their assistants	31.0	33.1
Bookkeepers and servicemen	2.3	5.0
Watchmen and cooks	3.9	4.1
Water and fuel haulers	--	8.7
Electricians	5.6	--
Total	42.8	50.9

The table shows that when the electric tractor was used, the labor of bookkeepers and servicemen was cut by more than half, that of water and fuel haulers was eliminated, although that of electricians was added. As a whole, labor productivity was almost 18 percent greater when the electric tractor was used.

Even greater labor productivity can be expected from improved electric tractors, specially designed attached machines, and cumulative experience in their exploitation. But even a 16-percent labor productivity increase in mobile field operations is significant, since these operations at present absorb about 45 percent of all kolkhoz labor. Thus, the stated increase represents a 7-percent saving of total annual kolkhoz labor. This saving of labor comes in a period of greatest tension in the balance of agricultural labor.

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The following table compares direct costs in the use of the two tractors:

Direct Costs per Hectare of Soft Plowing
(rubles)

<u>Elements</u>	<u>ET-5</u>	<u>STZ-MATI</u>
Fuel and grease	1.2	11.8
Electric power	13.8	--
Wages	5.8	3.2
Repairs	6.8	6.6
Total	27.6	21.6

The high cost of electric power shown in the table was due to the fact that a special rate had not been established for electric tractors and the power was paid for at a rate of 30 kopeks per kilowatt-hour. In the zones of the great hydroelectric plants, where mass utilization of electric tractors is planned, power cost will be considerably lower. The following table shows the effect of lower rates on power cost and on total direct costs:

Electric Power Costs at Varying Rates and
Total Direct Costs per Hectare of Soft Plowing

<u>Rate per Kilowatt-Hour</u> (kopeks)	<u>Power Cost</u> (rubles)	<u>Total Direct Cost</u> (rubles)
20	9.2	23.1
15	6.9	20.7
10	4.6	18.4
5	2.3	16.1

The table shows that if the rate for electric power is 15 kopeks per kilowatt-hour, total direct costs will be lower for electric tractors than for internal combustion tractors.

The table of direct costs does not reflect expenditures for wages of personnel and work of draft animals engaged in hauling fuel and water for internal combustion tractors; their working time amounts to about 10 man-days and 12.5 horse-days per 100 hectares of soft plowing. On the other hand, the data fails to reflect increased capital investments for equipment necessary to electric tractor operation, amortization of electric tractors, and repairs made on them. The following table compares costs of operation when other factors are added to direct costs:

Direct Costs and Other Costs per Hectare of Soft Plowing
(rubles)

<u>Elements</u>	<u>ET-5</u>	<u>STZ-MATI</u>
Fuel and grease	1.2	11.8
Electric power	13.8	--
Wages of production workers	5.8	3.2
Current repairs and maintenance	5.7	3.3
Amortization	13.0	5.4
Fuel hauling	--	3.0
Total	39.5	26.7

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The table shows that amortization cost is considerably higher for electric than for internal combustion tractors. This is so because electric tractors require additional installations and equipment such as field lines (about 5 kilometers per tractor), a mobile transformer substation, and cable. The cost of these is higher than that of the eliminated fuel storage facility cost. Amortization cost chargeable to electric tractor operation can be reduced above all by also using the installations for electrifying other agricultural production processes, primarily irrigation.

To raise the economic efficiency of electric tractor operation, special electric machine-tractor stations (EMTS) are to be created; the first six will be organized in the irrigated zone of Rostov Oblast, two of them in 1952. The EMTS, having at their disposal electric tractors and machines for soil preparation, crop care, and harvesting, as well as electrical installations (substations and lines), will assure electrification of field and stationary operations in kolkhozes and eventually of irrigation.

With creation of EMTS, it will be very important to liquidate the organizational gap which now exists between tractor power concentrated in MTS and electric power under control of Glavsel'elektro (Main Administration of Rural Electrification) organizations of the kolkhozes themselves. At present, MTS have no direct relations with workers engaged in agricultural electrification, a fact which makes more difficult the introduction of electric power into agricultural production operations and retards the most efficient utilization of electric power.

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